BMP: TEMPORARY SEDIMENT BASIN

Definition

A temporary barrier or dam with a controlled stormwater release structure formed by constructing an embankment of compacted soil across a drainageway.

Purpose

To detain sediment-laden runoff from disturbed areas in "wet" and "dry" storage long enough for the majority of the sediment to settle out.

Conditions Where Practice Applies

Below disturbed areas where the total contributing drainage area is equal to or greater than 1.2 hectares (3 acres). There must be sufficient space and appropriate topography for the construction of a temporary impoundment. These structures are limited to a useful life of 18 months unless they are designed as permanent impoundments. It is required that these measures, by virtue of their potential to impound large volumes of water, be designed by a qualified professional.

Planning Considerations

Effectiveness-

Sediment basins constructed as per this specification are, at best, 60% effective in trapping sediment which flows into them during large storm events (those which cause flow from the outfall pipe) or during periods of minimal vegetative cover at a construction site. Therefore, they should be used in conjunction with erosion control practices such as temporary seeding, mulching, diversion dikes, etc., to reduce the amount of sediment flowing into the basin.

The sediment removal efficiency problems noted for previous designs of the TEMPORARY SEDIMENT TRAP (BMP-13) are also applicable to the sediment basin. In order to contain the majority of sediment which flows to the structure, the basin should have a permanent pool, or wet storage area and a dry storage area which dewaters over time. The volume of the permanent pool (needed to protect against re-suspension of sediment and promote better settling conditions) must be 127 cubic meters per hectare (67 cubic yards per acre) of drainage area and the volume of dry storage above the permanent pool (needed to prevent "short-circuiting" of basin during larger storm events) must be an additional 127 cubic meters per hectare (67 cubic yards per acre) of drainage area. The total storage volume of the basin at the principal spillway riser crest will therefore be 254 cubic meters per hectare (134 cubic yards per acre) of drainage area.

Sediment basins, along with other perimeter controls which are intended to trap sediment, shall be constructed as a first step in any land disturbing activity and shall be made functional before upslope land disturbance takes place.

Location-

To improve the effectiveness of the basin, it should be located so as to intercept the largest possible amount of runoff from the disturbed area. The best locations are generally low areas and natural drainageways below disturbed areas. Drainage into the basin can be improved by the use of diversion dikes and ditches. The basin must not be located in a live stream but should be located to trap sediment-laden runoff before it enters a stream. The basin should not be located where its failure would result in the loss of life or interruption of the use or service of public utilities or roads.

Multiple Use-

Sediment basins may remain in place after construction and final site stabilization are completed to serve as permanent stormwater management structures. Because the most practical location for a sediment basin is often the most practical location for a stormwater management basin, it is often desirable to utilize these structures for permanent stormwater management purposes. It should be noted, however, that in most cases, a typical structure's outfall system will vary during the construction and post-construction periods. Care must be taken to avoid constructing an outfall system which will achieve the desired post. construction quantity or quality control but will not provide the necessary medium for the containment and settling of sediment-laden <u>construction</u> runoff. Notably, the design for permanent ponds is beyond the scope of these standards and specifications.

<u>Design Criteria</u>

Maximum Drainage Area-

The maximum allowable drainage area into a temporary sediment basin shall be 40 hectares (100 acres). It is recommended that when the drainage area to any one temporary basin exceeds 20 hectares (50 acres), an alterative design procedure which more accurately defines the specific hydrology and hydraulics of the site and the control measure be used. The design procedures in this standard and specification do not generate hydrographs, utilize storage volumes or provide a routing of the design storms; for a large drainage area, this may result in an excessively large diameter riser or an oversized basin. Notably, design considerations which are more accurate and project-specific than those in this specification are acceptable and encouraged with any size basin.

Basin Capacity-

The design storage capacity of the basin must be at least 254 cubic meters per hectare (134 cubic yards per acre) of total contributing drainage area. One half of the design volume shall be in the form of a permanent pool, and the remaining half as drawdown volume. The volume of the permanent pool shall be measured from the low point of the basin to the elevation corresponding to one half the total storage volume. The volume of the drawdown area shall be measured from the elevation of the permanent pool to the crest of the principal spillway (riser pipe). Sediment should be removed from the basin when the volume of the permanent pool has been reduced by one half. In no case shall the sediment cleanout level be higher than 300 millimeters (1 foot) below the bottom of the dewatering device. The elevation of the sediment cleanout level should be calculated and clearly marked on the plans and riser (since this part of the riser normally will be under water, a mark should appear above the permanent pool a measured distance above the cleanout elevation).

While attempting to attain the desired storage capacities, efforts should be made to keep embankment heights to a minimum. This precaution takes on added significance when the basin will only serve as a temporary measure or will need substantial retrofitting prior to functioning as a permanent measure. When site topography permits, the designer should give strong consideration to the use of excavation to obtain the required capacity and to possibly reduce the height of the embankment. This excavation can be performed in a manner which creates a wet storage forebay area or which increases the storage capacity over the entire length of the basin.

Basin Shape-

To improve sediment trapping efficiency of the basin, the effective flow length must be twice the effective flow width. This basin shape may be attained by properly selecting the site of the basin, by excavation, or by the use of baffles. See Appendix BMP-14a for pertinent design details.

Embankment Cross-Section-

For embankments of less than 3 meters (10 feet), the embankment must have a minimum top width of 2 meters (6 feet), and the side slopes must be 2:1 or flatter. In the case of an embankment 3 to 4 meters (10 to 14 feet) in height, the minimum top width shall be 2.5 meters (8 feet) and the side slopes shall be 2.5:1 or flatter. For 4.5 meter (15-foot) embankments (maximum allowed under these specifications), the top width must be 3 meters (10 feet) with maximum 2.5:1 side slopes.

Spillway Design-

The outlets for the basin shall consist of a combination of principal and emergency spillways. These outlets must pass the peak runoff expected from the contributing drainage area for a 25-year storm. If, due to site conditions and basin geometry, a separate emergency spillway is not feasible, the principal spillway must pass the entire peak runoff expected from the 25-year storm. However, an attempt to provide a separate emergency spillway should always be made (refer to "Emergency Spillway" later on in this section). Runoff computations shall be based upon the soil cover conditions which are expected to prevail during the life of the basin. Notably, the flow through the dewatering orifice cannot be utilized when calculating the 25 year storm elevation because of its potential to become clogged; therefore, available spillway storage must begin at the principal spillway riser crest.

The spillways designed by the procedures contained in the standard and specification <u>will not necessarily result in any reduction in the peak rate of runoff</u>. If a reduction in peak runoff is desired, the appropriate hydrographs/storm routings should be generated to choose the basin and outlet sizes.

Principle Spillway-

For maximum effectiveness, the principal spillway should consist of a vertical pipe or box of corrugated metal or reinforced concrete, with a minimum diameter of 380 millimeters (15 inches), joined by a watertight connection to a horizontal pipe (barrel) extending through the embankment and outletting beyond the downstream toe of the fill. If the principal spillway is used in conjunction with a separate emergency spillway, the principal spillway must be designed to pass at least the peak flow expected from of 2-year storm. If no emergency spillway is used, the principal spillway must be designed to pass the entire peak flow expected from a 25-year storm (see Appendix BMP-14a for design details).

Design Elevations-

The crest of the principal spillway shall be set at the elevation corresponding to the storage volume required - 127 cubic meters per hectare wet storage plus 127 cubic meters per hectare dry storage for a total of 254 cubic meters per hectare (134 cubic yards per acre). If the principal spillway is used in conjunction with an emergency spillway, this elevation shall be a minimum of 300 millimeters (1.0 foot) below the crest of the emergency spillway. In addition, a minimum freeboard of 300 millimeters shall be provided between the design high water (25-year) and the top of the embankment. If no emergency spillway is used, the crest of the principal spillway shall be a minimum of 1 meter (3 feet) below the top of the embankment; also, a minimum freeboard of 600 millimeters (2.0 feet) shall be provided between the design high water and the top of the embankment.

Anti-Vortex Device and Trash Rack-

An anti-vortex device and trash rack shall be attached to the top of the principal spillway to improve the flow characteristics of water into the spillway and prevent floating debris from blocking the principal spillway. The anti-vortex device shall be of the concentric type. See Appendix BMP-14a for design procedures for the anti-vortex device and trash rack.

Dewatering-

Provisions shall be made to dewater the basin down to the permanent pool elevation. Recent studies by the Washington Metropolitan Council of Governments have shown that it is necessary to provide at least a 6-hour drawdown time in the dry storage area in order to achieve up to 60% removal of sediment.

Dewatering of the dry storage should be done in a manner which removes the "cleaner" water without removing the potentially sediment-laden water found in the wet storage area or any appreciable quantities of floating debris. An economical and efficient device for performing the drawdown is a section of perforated vertical tubing which is connected to the principal spillway at two locations. By virtue of the potential for the dewatering device or orifice becoming clogged, no credit is given for drawdown by the device in the calculation of the principal or emergency spillway locations. The method for sizing the dewatering orifice and the associated flexible conduit is located in Appendix 14-a.

Base-

The base of the principal spillway must be firmly anchored to prevent its floating. If the riser of the spillway is greater than 3 meters (10 feet) in height, computations must be made to determine the anchoring requirements. A minimum factor of safety of 1.25 shall be used (downward forces = 1.25 x upward forces).

For risers 3 meters (10 feet) or less in height, the anchoring may be done in one of the two following ways:

1. A concrete base 450 millimeters (18 inches) thick and twice the width of riser diameter shall be used and the riser embedded 150 millimeters (6 inches) into the concrete. See Appendix BMP-14a for design details.

2. A square steel plate, a minimum of 6 millimeters (0.25 inches) thick and having a width equal to twice the diameter of the riser shall be used; it shall be covered with 750 millimeters (2.5 feet) of stone, gravel, or compacted soil to prevent flotation. See Appendix BMP-14a for design details.

   Note: If the steel base is used, special attention should be given to compaction so that 95% compaction is achieved over the plate. Also, added precautions should be taken to ensure that material over the plate is not removed accidently during removal of sediment from basin.

Barrel-

The barrel of the principal spillway, which extends through the embankment, shall be designed to carry the flow provided by the riser of the principal spillway with the water level at the crest of the emergency spillway. The connection between the riser and the barrel must be watertight. The outlet of the barrel must be protected to prevent erosion or scour of downstream area. See Appendix BMP-14a for design details.

Anti-Seep Collars-

Anti-seep collars shall be used on the barrel of the principal spillway within the normal saturation zone of the embankment to increase the seepage length by at least 10%, if either of the following two conditions is met:

1. The settled height of the embankment exceeds 3 meters (10 feet).

2. The embankment has a low silt-clay content (Unified Soil Classes SM or GM) and the barrel is greater than 250 millimeters (10 inches) in diameter.

The anti-seep collars shall be installed within the saturated zone. The maximum spacing between collars shall be 14 times the projection of the collars above the barrel. Collars shall not be closer than 600 millimeters (2 feet) to a pipe joint. Collars should be placed sufficiently far apart to allow space for hauling and compacting equipment. <u>Precautions should be taken to ensure that 95% compaction is achieved around the collars</u>. Connections between the collars and the barrel shall be watertight. See Appendix BMP-14a for details and design procedure.

Alternatives to Anti-Seepage Collars-

Anti-seep collars are designed to control seepage and piping along the barrel by increasing the flow length and thus making any flow along the barrel travel a longer distance. However, due to the constraints that collars impose on embankment fill placement and compaction, collars may sometimes be ineffective or actually result in an increase in seepage and piping.

Alternative measures have been developed and are being incorporated into embankment designs. These measures include a structure known as a "filter diaphragm." A filter diaphragm consists of a layer of sand and fine gravel which runs through the dam embankment perpendicular to the barrel. Typically, the structure is 100 to 125 millimeters (4 to 5 inches) in width, approximately 300 millimeters (1 foot) in height and is located at the barrel elevation at its intersection with the upper bounds of the seepage zone. The measure controls the transport of embankment fines, which is the major concern with piping and seepage. The diaphragm channels any undesirable flow through the fine-graded material, which traps any embankment material being transported. The flow is then conveyed out of the embankment through a perforated toe drain.

The critical design element of the filter diaphragm is the grain-size distribution of the filter material which is determined by the grain-size distribution of the embankment fill material. The use and design of these measures must be based on site-specific geotechnical information and should be supervised by a qualified professional.

Emergency Spillway

The emergency spillway acts as a safety release for a sediment basin, or any impoundment type structure, by conveying the larger, less frequent storms through the basin without damage to the embankment. The emergency spillway also acts as its name implies - in case of an emergency such as excessive sedimentation or damage to the riser which prevents flow through the principal spillway. The emergency spillway shall consist of an open channel (earthen and vegetated) constructed adjacent to the embankment over undisturbed material (not fill). Where conditions will not allow the construction of an emergency spillway on undisturbed material, a spillway may be constructed of a non-erodible material such as riprap. The spillway shall have a control section at least 6 meters (20 feet) in length. The control section is a level portion of the spillway channel at the highest elevation in the channel. See Appendix BMP-14a for details and design procedure.

An evaluation of site and downstream conditions must be made to determine the feasibility and justification for the incorporation of an emergency spillway. In some cases, the site topography does not allow a spillway to be constructed in undisturbed material, and the temporary nature of the facility may not warrant the cost of disturbing more acreage to construct and armor a spillway. The principal spillway should then be sized to convey all the design storms. If the facility is designed as a permanent facility with downstream restrictions, the added expense of constructing and armoring an emergency spillway may be justified.

Capacity-

The emergency spillway shall be designed to carry the portion of the peak rate of runoff expected from a 25-year storm which is not carried by the principal spillway. See Appendix BMP-14a for design procedure and details.

Design Elevations-

The 25-year storm elevation through the emergency spillway shall be at least 300 millimeters (1 foot) below the top of the embankment. The crest of the emergency spillway channel shall be above the 2-year storm water surface elevation.

Location-

The emergency spillway channel shall be located so that it will not be constructed over fill material. The channel shall be located so as to avoid sharp turns or bends. The channel shall return the flow of water to a defined channel downstream from the embankment.

Maximum Velocities-

The maximum allowable velocity in the emergency spillway channel will depend upon the type of lining used. For vegetated linings, allowable velocities are listed in Table 17-1 (BMP-17, STORMWATER CONVEYANCE CHANNELS). For non-erodible linings, such as concrete or riprap, design velocities may be increased. However, the emergency spillway channel shall return the flow to the receiving channel at a non-eroding velocity. See Appendix BMP-14a for design procedure and details.

Stabilization-

The embankment of the sediment basin shall receive temporary or permanent seeding immediately after installation (see TEMPORARY SEEDING, BMP-31 or PERMANENT SEEDING, BMP-32). If excavation is required in the basin, side slopes should not be steeper than 1.5:1.

Disposal-

Sediment shall be removed from the basin when the sediment level is no higher than 300 millimeters (1 foot) below the bottom of the dewatering orifice, or one-half of the permanent pool volume, whichever is lower. Plans for the sediment basin shall indicate the methods for disposing of sediment removed from the basin. Possible alternatives are the use of the material in fill areas on-site or removal to an approved off-site location.

Sediment basin plans shall indicate the final disposition of the sediment basin after the upstream drainage area is stabilized. The plans shall include methods for the removal of excess water lying over the sediment, stabilization of the basin site, and the disposal of any excess material. Where the sediment basin has been designed as a permanent stormwater management basin, plans should also address the steps necessary for the conversion from sediment basin to a permanent detention or retention facility.

Safety-

Sediment basins can be attractive to children and can be dangerous. They should; therefore, be fenced or otherwise made inaccessible to persons or animals unless this is deemed unnecessary by the plan approving authority due to the remoteness of the site or other circumstances. Strategically placed signs around the impoundment reading "DANGER-QUICKSAND" should also be installed. In any case, local ordinances and regulations regarding health and safety must be adhered to (see BMP-1, SAFETY FENCE).

Construction Specifications

Site Preparation-

Areas under the embankment or any structural works related to the basin shall be cleared, grubbed, and stripped of topsoil to remove trees, vegetation, roots, or other objectionable material. In order to facilitate cleanout and restoration, the area of most frequent inundation (measured from the top of the principal spillway) will be cleared of all brush and trees.

Cutoff Trench-

For earth-fill embankments, a cutoff trench shall be excavated along the centerline of the dam. The trench must extend at least 300 millimeters (1 foot) into a stable, impervious layer of soil and have a minimum depth of 600 millimeters (2 feet). The cutoff trench shall extend up both abutments to the riser crest elevation. The minimum bottom width shall be 1.2 meters (4 feet), but also must be wide enough to permit operation of compaction equipment. The side slopes shall be no steeper than 1:1.

Compaction requirements shall be the same as those for the embankment. The trench shall be drained during the backfilling/compacting operations.

Embankment-

The fill material shall be taken from approved borrow areas. It shall be clean mineral soil, free of roots, woody vegetation, stumps, sod, oversized stones, rocks, or other perishable or objectionable material. The material selected must have enough strength for the dam to remain stable and be tight enough, when properly compacted, to prevent excessive percolation of water through the dam. Fill containing particles ranging from small gravel or coarse sand to fine sand and clay in desired proportion is appropriate. Any embankment material should contain approximately 20% clay particles by weight. Using the Unified Soil Classification System, SC (clayey sand), GC (clayey gravel) and CL ("low liquid limit" clay) are among the preferred types of embankment soils. Areas on which fill is to be placed shall be scarified prior to placement of fill. The fill material should contain the proper amount of moisture to ensure that 95% compaction will be achieved. Fill material will be placed in 150 millimeter (6-inch) continuous layers over the entire length of the fill. Compaction shall be obtained by routing the hauling equipment over the fill so that the entire surface of the fill is transversed by at least one wheel or tread track of the equipment, or by using a compactor. Special care shall be taken in compacting around the anti-seep collars (compact by hand, if necessary) to avoid damage and achieve desired compaction. The embankment shall be constructed to an elevation 10% higher than the design height to allow for settlement if compaction is obtained with hauling equipment. If compactors are used for compaction, the overbuild may be reduced to not less than 5%.

Principal Spillway-

The riser of the principal spillway shall be securely attached to the barrel by a watertight connection. The barrel and riser shall be placed on a firmly compacted soil foundation. The base of the riser shall be firmly anchored according to design criteria to prevent its floating. Pervious materials such as sand, gravel, or crushed stone shall not be used as backfill around the barrel or anti-seep collars. Special care shall be taken in compacting around the anti-seep collars (compact by hand, if necessary). Fill material shall be placed around the pipe in 100 millimeter (4-inch) layers and compacted until 95% compaction is achieved. A minimum of 600 millimeters (2 feet) of fill shall be hand-compacted over the barrel before crossing it with construction equipment.

Emergency Spillway-

Vegetative emergency spillways shall not be constructed over fill material. Design elevations, widths, entrance and exit channel slopes are critical to the successful operation of the spillway and should be adhered to closely during construction.

Vegetative Stabilization-

The embankment and emergency spillway of the sediment basin shall be stabilized with temporary or permanent vegetation immediately after installation of the basin (see TEMPORARY SEEDING, BMP-31 or PERMANENT SEEDING, BMP-32).

Erosion and Sediment Control-

The construction of the sediment basin shall be carried out in a manner such that it does not result in sediment problems downstream.

Safety-

All state and local requirements shall be met concerning fencing and signs warning the public of the hazards of soft, saturated sediment and flood waters (refer to BMP-1, SAFETY FENCE).

Maintenance

The basin embankment should be checked regularly to ensure that it is structurally sound and has not been damaged by erosion or construction equipment.

The emergency spillway should be checked regularly to ensure that its lining is well established and erosion-resistant.

The basin should be checked after each runoff-producing rainfall for sediment cleanout. When the sediment reaches the clean-out level, it shall be removed and properly disposed.